RL-TR-92-80
Final Technical Report
May 1992

LAND ANALYSIS SUPPORT SYSTEM (LASS)

PAR Government System Corporation (PGSC)

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	May 1992	Final

4. TITLE AND SUBTITLE

LAND ANALYSIS SUPPORT SYSTEM (LASS)

5. FUNDING NUMBERS

C - F30602-88-D-0017
Task 3
PR - 4306
TA - Q5
WU - G1

6. AUTHOR(S)

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Rome Laboratory (IRRP)
Griffiss AFB NY 13441-5700

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

RL-TR-92-80

11. SUPPLEMENTARY NOTES

Rome Laboratory project engineer: James A. McNeely/IRRP/315-330-2110

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This report documents the technical accomplishments of the Land Analysis Support System (LASS). The LASS is an integrated hardware/software system designed to provide the means to produce earth surface data for regions of the world that are beyond the near term production plans of the Defense Mapping Agency. The LASS design is based on the capabilities provided by the Land Analysis System (LAS). LAS is an image analysis system developed cooperatively by the Goddard Space Flight Center (GSFC) and USGS EROS Data Center (EDC). The LASS provides the digital image processing capability that is necessary to convert image data into a digital proof plot. These proof plots are input into either the SCITEX or the color Fire System, where four color separates are made. These color separates are used to produce the color printing plates, contact negatives or color lithography from which the image maps are made.

14. SUBJECT TERMS

Image maps, color separates, digital proofs

15. NUMBER OF PAGES 36

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

FINAL REPORT

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SECTION 1. INTRODUCTION

This report, CDRL C008, describes the results of Rome Air Development Center (RADC) Contract F30602-88-D-0017, entitled Land Analysis Support System (LASS). The contract was performed by PAR Government Systems Corporation (PGSC) between 13 July 1990 and 30 December 1990.

1.1. Background

The Land Analysis Support System (LASS) is an integrated hardware/software complex designed to provide the means to create Landsat Image Maps for regions of the world that are beyond the near term DMA production plans. In addition, it provides a testbed environment for the development of new techniques in image processing. The LASS resides at DMA's Hydrographic/Topographic Center.

1.2. Design Summary

The remainder of this report is organized as follows: Section 2 provides an overview of the LASS including a short discussion of its place in the overall image mapping production process. Section 3 describes the LASS design including modifications that were made to the IEF/RWPF environment to enable LASS capabilities, additions to the IEF hardware configuration to provide a proof plot generation capability, and the development of software to generate image map files in formats for importation to a SCITEX environment. Section 4 summarizes LASS developments and suggests some future directions to improve the IEF/LASS image map generation capabilities. Appendix A describes a prototype development activity to 'engrave' contour information on LASS produced image maps. Appendix B describes the steps that would be required to convert the current LASS environment back to the Unix-based RWPF environment. Appendix C describes the steps required to enable a high resolution display capability.

1.3. References

The following documents of the issue shown, form a part of this final report. In the event of a conflict between the documents referenced herein, and the content of this final report, the content of this final report shall be considered a superseding requirement.

1.3.1. Government Documents

DOD STD 7935 - 15 February 1983

LASS Operations Manual

1.3.2. Non-Government Documents

LAS Version 5.0 Documentation; USGS EROS Data Center Sioux Falls, South Dakota:

LAS Programmer's Manual; February 1990

DMS Functional Overview;

Overview of the Land Analysis System; January 1990

Overview of the LAS Display Management Subsystem; January 1990

Large Area Mosaicking System Documentation; USGS EROS Data Center, Sioux Falls South Dakota:

Overview of the Large Area Mosaicking System; August 1989

SCITEX Handshake Foreign File Transfer Protocol, Scitex Document No. 788-37898A, revision A; April 1988

Guide to Maintaining a VMS System, Version 5.0, Digital Equipment Corporation, order number AA-LA34A-TE; April 1988

Guide to VMS Performance Management, Version 5.0, Digital Equipment Corporation, order number AA-LA43A-TE; April 1988

Guide to Setting Up a VMS System, Version 5.0, Digital Equipment Corporation, order number AA-LA25A-TE; April 1988

VMS Installation and Operations: VAX-11/780,785, Version 5.0, Digital Equipment Corporation, order number AA-LB29A-TE; April 1988

VMS Version 5.0 Release Notes, Digital Equipment Corporation

SECTION 2. SYSTEM OVERVIEW

The Land Analysis Support System (LASS) upgrades the DMA Image Exploitation Facility (IEF) to provide DMA with the means to create Landsat Image Maps for regions of the world that are beyond the near term DMA production plans.

The image mapping capability of the IEF/LASS is based on the facilities provided by the Land Analysis System (LAS) software package. LAS is an image analysis system developed cooperatively by the Goddard Space Flight Center (GSFC) and the USGS EROS Data Center (EDC). The Land Analysis Support System provides digital image processing capabilities that are necessary to convert Thematic Mapper (TM) data input on computer compatible magnetic tape to proof plots and data output on computer compatible magnetic tape for eventual production as Landsat Image Maps. Figure 2-1 depicts this image mapping process and LASS's part in that process.

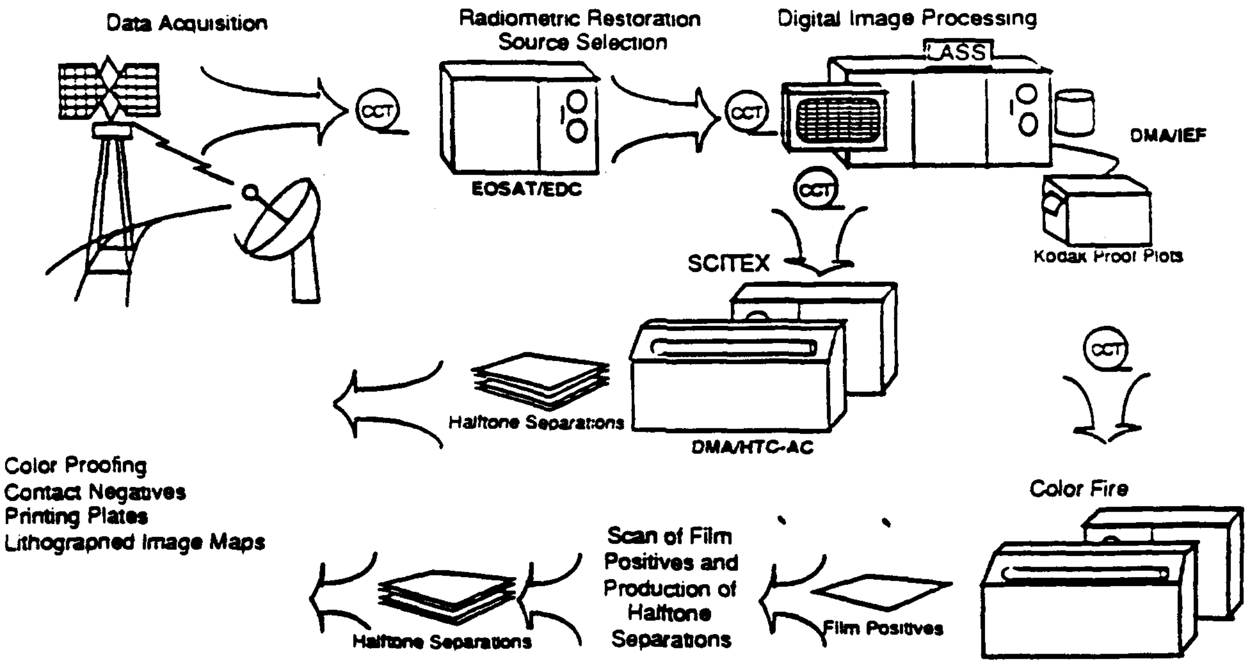

Figure 2-1 The Image Map Production Process

The image mapping process begins with data acquisition and the processes of radiometric restoration and scene selection. These steps take place at EOSAT and EDC. The image mapping process continues with input to the digital image processing capabilities provided by the LASS in the form of computer compatible tapes. Output from LASS is in the form of proof plots (from the Kodak printer) and computer compatible tapes. Magnetic tapes created for input to a SCITEX system are created with four separations that will eventually become the cyan, magenta, yellow, and black process color printing plates. Creation of

halftone separations, that then undergo color proofing, creation of contact negatives and printing plates, and production of image maps via color lithography, takes place on the SCITEX system. Magnetic tapes may also be created for input to a Color Fire 240 Printer, which also requires the generation and scanning of film positives prior to the creation of halftone separations.

SECTION 3. SYSTEM DESIGN

The implementation of LASS image mapping capabilities required modifications to the existing IEF/RWPF hardware and software configuration, the addition of a proof plot generation capability based on a Kodak Continuous Tone Digital Image Printer, and the development of software to generate image map data in a computer compatible magnetic tape format that can be read into SCITEX systems. These activities are described in greater detail in the following sections.

3.1. IEF Modifications

In order to install LAS on the IEF a variety of modifications to the IEF hardware and software configurations were required. Modifications were made to the VAX-11/785 processor, the Gould/DeAnza image processing display system, and to the Sun-2/170 workstations. Figure 3-1 is a schematic diagram of the current IEF hardware configuration following these modifications.

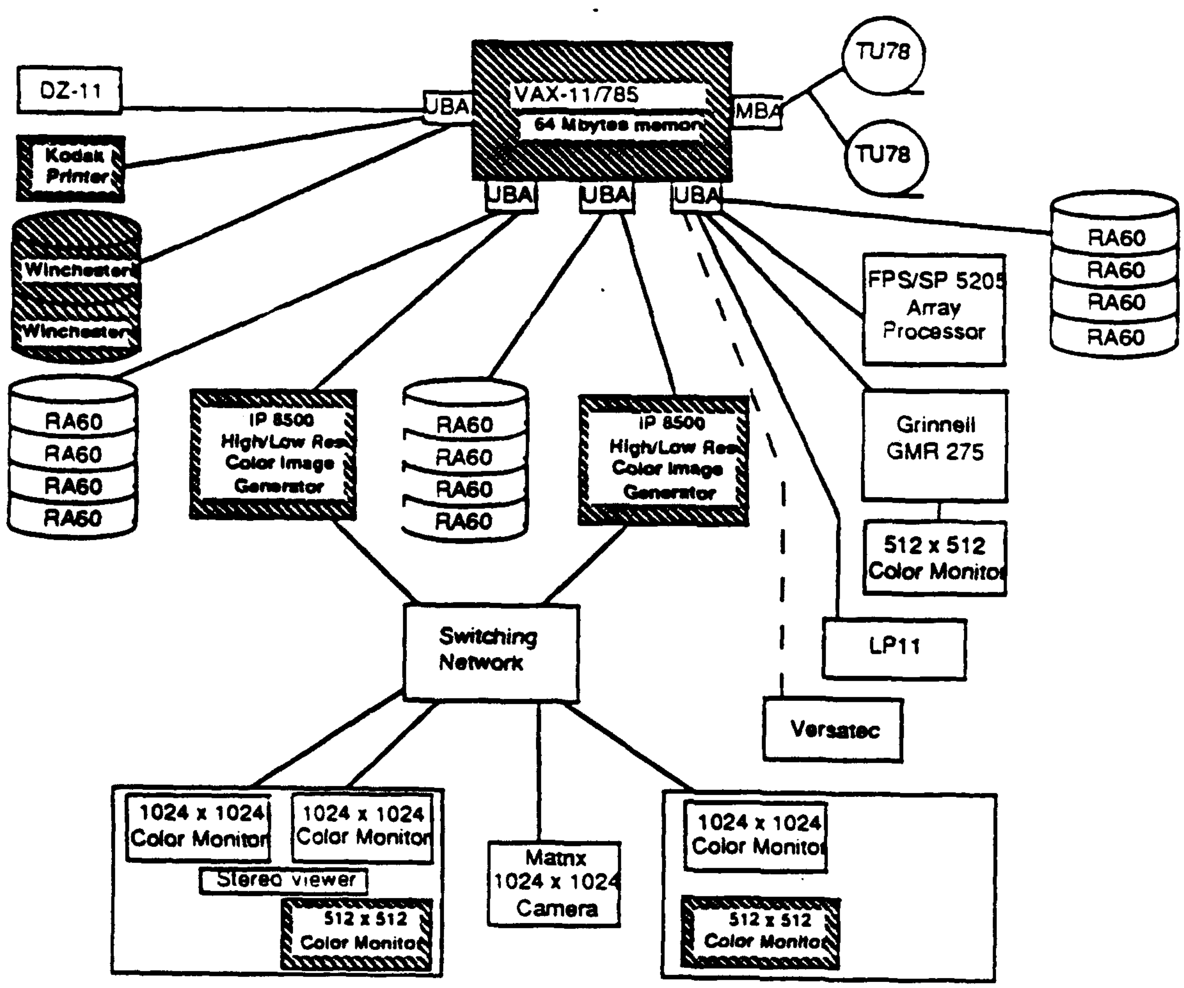

Figure 3-1 Current IEF Hardware Configuration

3.1.1. VAX-11/785

LASS modifications were most extensive on the VAX-11/785 processor. Modifications included additional hardware and new operating system software, details of which are provided below.

System memory on the VAX-11/785 was upgraded from 8 to 64 megabytes to support the large image formats typical of DMA image processing. The memory upgrade was accomplished by replacing the eight (8) 1 megabyte memory boards used on the prior IEF configuration with eight (8) 8 megabyte memory boards from Clearpoint Research Corporation to provide 64 megabytes of memory. Sixty four megabytes is the maximum amount of memory that the VAX-11/785 processor supports.

Two Winchester disk drives were added to the configuration each with an additional 780 (660 formatted) megabytes of disk space, to accommodate the on-line storage and manipulation of large image data collections.

LASS proof plot generation is provided by a KODAK color printer. Details about the installation and integration of the proof plotting capability are provided in Section 3.3.

Figure 3-2 illustrates the current physical layout of the IEF/VAX hardware configuration. This layout was constrained in part by the maximum permissible cable lengths and the locations of available Unibus connections.

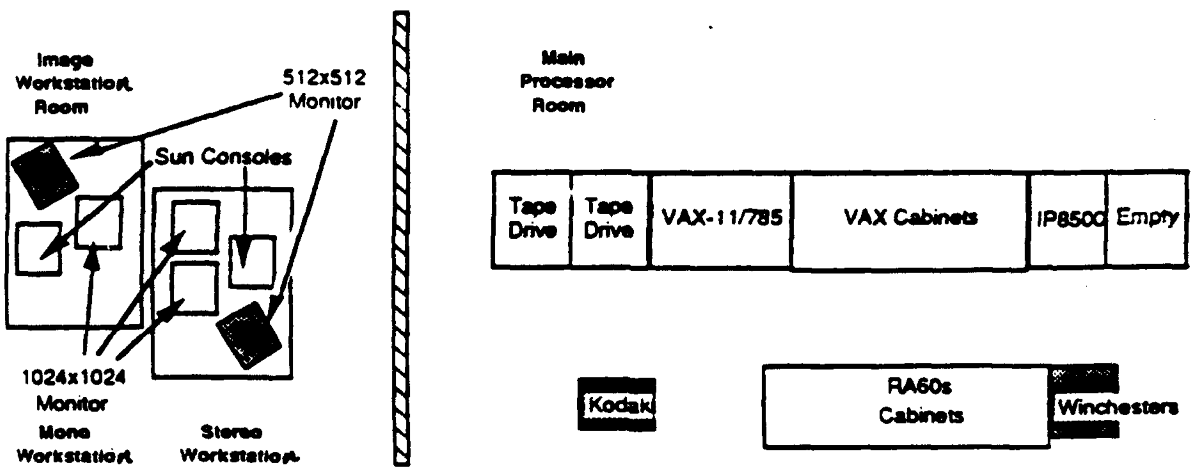

Figure 3-2 IEF/VAX Hardware Layout

The most recent version of the Digital Equipment Corporation (DEC) VAX/VMS operating system, VMS 5.3, was installed on the IEF. The LAS software package requires the VMS operating system. To support compiling the LAS package and to provide support for the development and installation of the Scitex

conversion software, the KODAK Printer interface, and the VICOM monitor device drivers, the most recent versions of the DEC FORTRAN and C language compilers were also installed on the VAX-11/785. All software written for the LASS contract was written using either the C language or the LAS PDF command file language. DEC software licenses were registered with the VMS license management facility for the VMS operating system, and the FORTRAN and C compilers.

Once all of the above hardware and software modifications were accomplished, the VMS AUTOGEN command procedure was executed to automatically tailor the system's operating system parameters to the current hardware configuration.

At the recommendation of personnel from EDC, the ten previously existing data disk packs (all of the RA60 disk drives except for the two used to maintain the operating system and LAS software respectively), and the two newly integrated Winchester disk drives were 'bound' into a single virtual disk volume using the VMS MOUNT/BIND utility. This practice permits the LAS software and users to use as much disk space as necessary to perform image processing functions without the need to be concerned with developing an effective disk space usage strategy[1].

To ease the transition for users already familiar with the IEF's former Unix environment, a publicly available emulation of the Unix vi text editor (originally developed by Greg Wonderly, Mathematics Department, Oklahoma State University, and obtained from the Usenet network) was installed in addition to a number of other command procedures to provide 'Unix-like' capabilities on the LASS.

During the course of LASS integration and testing a number of modifications were made to the operating system parameters and authorized user resource limits to permit better utilization of the IEF environment. Most of these modifications were performed using the DEC AUTOGEN facility mentioned above. However, the KODAK interface software required that the SYSGEN VIRTUALPAGECNT parameter be increased in order to build and use the KODAK interface software. Also, the working set parameters associated with user accounts were increased to permit better use of the increased available memory by

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[1] PGSC personnel recommended against this disk binding because of the potential problems that can result should one of the individual disk drives or disk packs fail, especially considering the relative unreliability of the RA60 disk packs as compared to fixed disk technology. Should one of the disks in a virtual disk volume suffer a disk crash or intermittent failure, the entire virtual disk volume is essentially corrupted. Due to the time required to create a backup copy of the virtual disk contents, approximately an hour per disk pack, there is no effective way to create a recoverable duplicate of the virtual disk contents. PGSC recommended that the two Winchester disk drives be used as one virtual disk and the ten RA60 disk drives be bound into a second virtual disk. In that way, should one of the virtual disks become corrupted, at least limited production could continue on the other while repairs are initiated. Relatively simple disk usage strategies could be developed to balance the load on either virtual disk.

memory-intensive image processing tasks. The working set size increases were performed following analysis of image accounting statistics and working-set sizes during LAS testing. Changes to the user account parameters were incorporated into a VMS command procedure, ADDUSER.COM, to automate the procedures involved in creating new user accounts. Often used LAS executable image files, which were identified through analysis of image accounting statistics, were installed as sharable VMS images to enhance system performance.

3.1.2. Gould/DeAnza Workstations

Modifications to the Gould/DeAnza workstations were necessitated by the need to provide display monitors supported by the current capabilities of the LAS software package. Two, low resolution (512x512) monitors were acquired from VICOM in addition to the current VICOM Systems Inc., supported device driver and diagnostic software. The VICOM device drivers and the diagnostic software were installed on the VAX's system disk. This software was configured to be loaded at system startup and made accessible to the LAS package as the LAS devices LORES1 and LORES2. Details on this configuration can be found in the LASS Operations Manual.

The physical location of the 512x512 monitors in the Gould/DeAnza workstations was an issue with four possible options:

- Installation of both 512x512 monitors in place of the stereo workstation's two 1024x1024 monitors.
- Installation of one 512x512 monitor in place of one 1024x1024 monitor on the stereo workstation and installation of the other 512 x 512 monitor in place of the 1024 x 1024 monitor on the mono workstation.
- Installation of the 512x512 monitors in place of the current status display monitors on each workstation.
- Installation of the 512x512 monitors on the work table surface of each workstation.

The first three options were rejected because they would have impacted the Unix system's capabilities unduly, would have necessitated acquiring rack mounts for the low resolution display monitors, and would not have adapted well to the standard LAS requirement for a single display allocated to each user. The fourth option, installation of the display monitors on the workstation table tops, avoids those impacts and facilitates operator interaction with the displays. The latter is most important during control point selection

in support of the image mosaicking procedures where the operator must be as close as possible to the display.

3.1.3. SUN-2/170

The SUN2 workstations that are connected via Ethernet to the VAX-11/785 processor are not able to use the Ethernet for inter-processor communication as is possible in the Unix-based IEF configuration. Common software communication protocols are required to use the Ethernet in this manner. The standard VMS and SUN2 operating systems do not support a compatible Ethernet communication protocol. As an alternative, to provide for communication between the SUN2 based workstations and the VAX-11/785 processor, an RS-232 terminal line interface was provided.

Two RS-232 cables were acquired and were used to connect the SUNS to the VAX through the SUN2's terminal ports and the VAX's DZ-11. The Sun workstations provide a terminal interface software tool,*tip*, that provides the necessary hooks to enable a login, virtual terminal window on the VAX. The window is created from the SUN2 consoles. A VMS terminal definition file for the SUN was obtained from EDC and installed. Although not 100% compatible with VMS it does allow for LAS tutorial mode entry and limited VMS editor support. The software required to use the Ethernet interface and the benefits this would provide to LASS operations are discussed in Section 4.

3.2. Kodak Image Print

A KODAK XL/700 Digital Continuous Tone color printer was interfaced with the VAX-11/785 to provide a proof plot generation capability. The KODAK device drivers and the user interface software acquired from Command Systems Group were installed on the VAX's system disk in a directory whose logical name is KODAK. The KODAK printer device drivers were configured to be loaded at system startup and the user interface software, XLPRINT, was made easily accessible to LASS users by creating an XLPRINT symbol each time a user logs on to the system. Details about the KODAK user interface, how it is accessed, and how it operates can be found in the LASS Operations Manual.

3.2.1. Kodak Calibration

In order to assure consistent colors between the various image output devices supported by the LASS configuration (Scitex compatible magnetic tape, Kodak printer, DeAnza monitor) a procedure has been developed to aid in the calibration of devices. The calibration starts with output from a designated device that is considered to be calibrated and works backwards to form color correction tables for other devices. The USGS Scitex system's laser plotter was selected as the baseline calibration device. Because low to high saturation rates of colors on different output devices vary, a color correction table between fixed grey

intensity levels, was defined to approximate saturation rates between devices. Color correction tables were created for each device by performing a comparison of color wedges generated by the device.

3.3. Scitex Conversion

Software was prepared to enable the generation of image map data on computer compatible magnetic tapes that can be input to Scitex systems. During the course of development and testing of this software, two Scitex systems were used as targets for validating this capability: the Scitex system at the U.S. Geological Survey's Eastern Mapping Center in Reston, Virginia, and the Scitex system at DMA-AC in St. Louis, Missouri. Software to generate two formats were prepared to deal with the fact that not all Scitex systems are able to read and interpret the Scitex data import format known as Handshake format. The Scitex at DMA-AC can read and interpret Handshake format, the Scitex at USGS-EMC cannot.

The generation of image data in a format not requiring Scitex Handshake capabilities uses existing capabilities of the LAS software package. The LAS TAPEOUT function has options to produce a magnetic tape format that can be read by Scitex systems. Importation of this data on a Scitex system requires that the data be passed a single band at a time, necessitating effort on the Scitex system to create an image file with all four (cyan, magenta, yellow, and black) bands interleaved. In addition, information about the pixel size and map scale to be used by the Scitex color separation plotting capabilities must be manually transmitted to the Scitex operators.

A LAS PDF (command file) was prepared to aid IEF/LASS users in following the steps of adding a calibration color bar to images; converting the images to cyan, magenta, yellow, and black process color separations; stretching the generated black band to permit black overprints to be visible; and using the proper parameters for the LAS TAPEOUT function to create a computer compatible magnetic tape that can be read on Scitex systems. This LAS command file, USGSSCITEX.PDF, is available to users in LAS TUTOR mode, providing a menu based, fill in the blanks, user interface complete with on-line help for the meanings of the command file parameters.

During the course of LASS implementation, testing, and training, a variety of computer compatible magnetic tapes of LAS image data were generated and read into the USGS-EMC Scitex System. Color separation negatives were created on the Scitex laser plotter and Cromalin color proofs were created for the Tingo Maria map sheet area and for the Baghdad, Iraq area. The latter image was created by merging Landsat and SPOT imagery.

The generation of Scitex Handshake format on the IEF/LASS permits the automatic transmittal of image data in a band inter-leaved format and with the desired final map scale in a single computer compatible

magnetic tape file. This method of image data transmittal to the Scitex system precludes a number of extra processing steps that are required where Scitex Handshake capabilities are not available.

A LAS command file, ACSCITEX.PDF, provides the same support as the USGSSCITEX.PDF except that the newly developed HANDSHAKE function is included to create a computer compatible magnetic tape.

During the course of LASS implementation, testing, and training, computer compatible magnetic tapes of LAS image data in Scitex handshake format for the Tingo Maria map sheet area and for the Baghdad, Iraq area were created and sent to St. Louis where they were successfully read into the DMA-AC Scitex System.

SECTION 4. SUMMARY

The purpose of the LASS implementation was to provide DMA with the means to create Landsat Image Maps by enhancing the capabilities of the IEF. Analysis of the existing hardware/software facilities of the IEF, Scitex systems, and the LAS software package identified the integration requirements between these three systems. The IEF was modified to support these requirements, the LAS software was integrated into the IEF environment, and interfaces were developed and integrated to permit the output of the IEF image processing capabilities to be used as input to Scitex systems. In addition, a hardware proofing device was integrated to help insure correctness of image colors prior to the creation of computer compatible magnetic tape output to Scitex systems.

A sample prototype product development activity that was carried out during the LASS implementation was the integration of contour information into an image map. The procedures involved in this activity are described in Appendix X.

The activities involved in implementing the IEF/LASS image map production capabilities were described in Section 3 of this report. The use of these facilities is described in the LASS Operations Manual. Additional details about the hardware/software integration and development, and the capabilities of the enhanced IEF/LASS environment may be found in the LASS User Manual.

4.1. Recommendations

During the course of implementing LASS image mapping capabilities into the IEF environment, a number of possible improvements to that environment suggested themselves. Some of those are described below.

The KODAK proof plot generation capability utilizes a user interface menu package developed by Command Systems Group. The image data format that is downloaded into the KODAK printer is easily created in the VMS environment. It is this format that the user interface menu package prefers. Unfortunately, the LAS data export functions do not currently create this format. At PGSC's request Command Systems Group added support for the data format that LAS export functions create, however this data format is accessed much more slowly than the KODAK preferred format. A fairly easy task would be to create a LAS function to generate the data format preferred by the KODAK interface software directly from the LAS internal format. This would permit proof plots to be generated somewhat faster by permitting much faster access to image data.

An additional enhancement that would increase the utility of the Kodak printer would be the development of a LAS function to quickly transform an image which is larger than the maximum KODAK image size (2Kx2K) into a size that would fit in the KODAK's memory.

The Sun console interface to the LAS/TAE environment via the RS-232 cables installed during LASS implementation provides a simple, but not very user friendly, interface. Users are restricted to a single login window into the VAX and are limited to the transmission speed provided by the RS-232 interface. Meanwhile the Ethernet interface still exists between the SUN2 workstations and the VAX-11/785 processor, it lacks only a compatible network protocol on the two systems to enable an enhanced user interface.

The simplest solution to providing a compatible network interface is to install a VMS compatible TCP/IP protocol interface on the VAX-11/785. Using a TCP/IP network protocol, users would be able to generate many login windows from the SUN2 SunWindows environment via the Unix *telnet* utility. With that capability, users would be better able to monitor the progress of image processing jobs, manage disk space, reply to requests to the operator to mount and dismount magnetic tapes, as examples.

APPENDIX A CONTOUR ENGRAVING

This appendix provides a detailed set of commands and explanations for how to portray contours on a Landsat scene using existing LAS 5.0 tools. This was a prototype development effort, thus the procedure is not very elegant (as illustrated by Figure A-1) or efficient. Upon certification that the prototype is a desired product, then various optimized processing steps could be incorporated into the procedure. The two most effective steps (illustrated in Figure A-2) would be to 1) directly register either the graphics overlay file or the labeled table file containing the contours to the final Landsat scene and 2) "engrave" the contours onto the Landsat imagery bands directly from the graphics overlay file.

The Gerber contour data obtained from the DMAAC was derived from DTED which was extracted from SAR imagery. The contours covered the area from 9° to 9°30' South Latitude and from 76° to 76°30' West Longitude, which is to the west of the central part of Tingo Maria, Peru. Some information was extracted or surmised from the Gerber files' header, although that information was never explicitly used. The map projection is Transverse Mercator (using -76°15' longitude as the central meridian and 0° as the pole of projection), the scale is 1:100,000, the coordinates are expressed in mils (0.001 inch), and elevation values are in meters. The datum was not specified. It would have been more desirable to have the contours generated by DMAAC with the same map projection as used by the Tingo Maria, Peru prototype image map (e.g., the central meridian for the Tingo Maria sheet was -75° longitude).

Two sets of contour data were provided, one containing 100 meter contour intervals, the other containing 500 meter contour intervals. Only the 500 meter contour intervals were processed during the prototype study.

Two additional study areas related to the presentation of contours on the image maps include portrayal of maximum elevation values in grid cells and contour labeling.

- The contour labels associated with the contours used for this study are available, but additional study is needed to resolve how to extract them accurately from the Gerber plotter commands. Each label has a position and rotation value, relative to the lower left corner of the label text. The association of the label to a specific contour is then dependent on the font size and the angle of rotation. It would be desirable to work directly with contours which have elevation values associated with them as attributes, instead of surmising that information from plot data. The uncertainties associated with the plot data are magnified by the processing methodology used within the LAS environment. Some of the processing performed on the graphics generated by the contours' spatial coordinates will not work for contour labels.

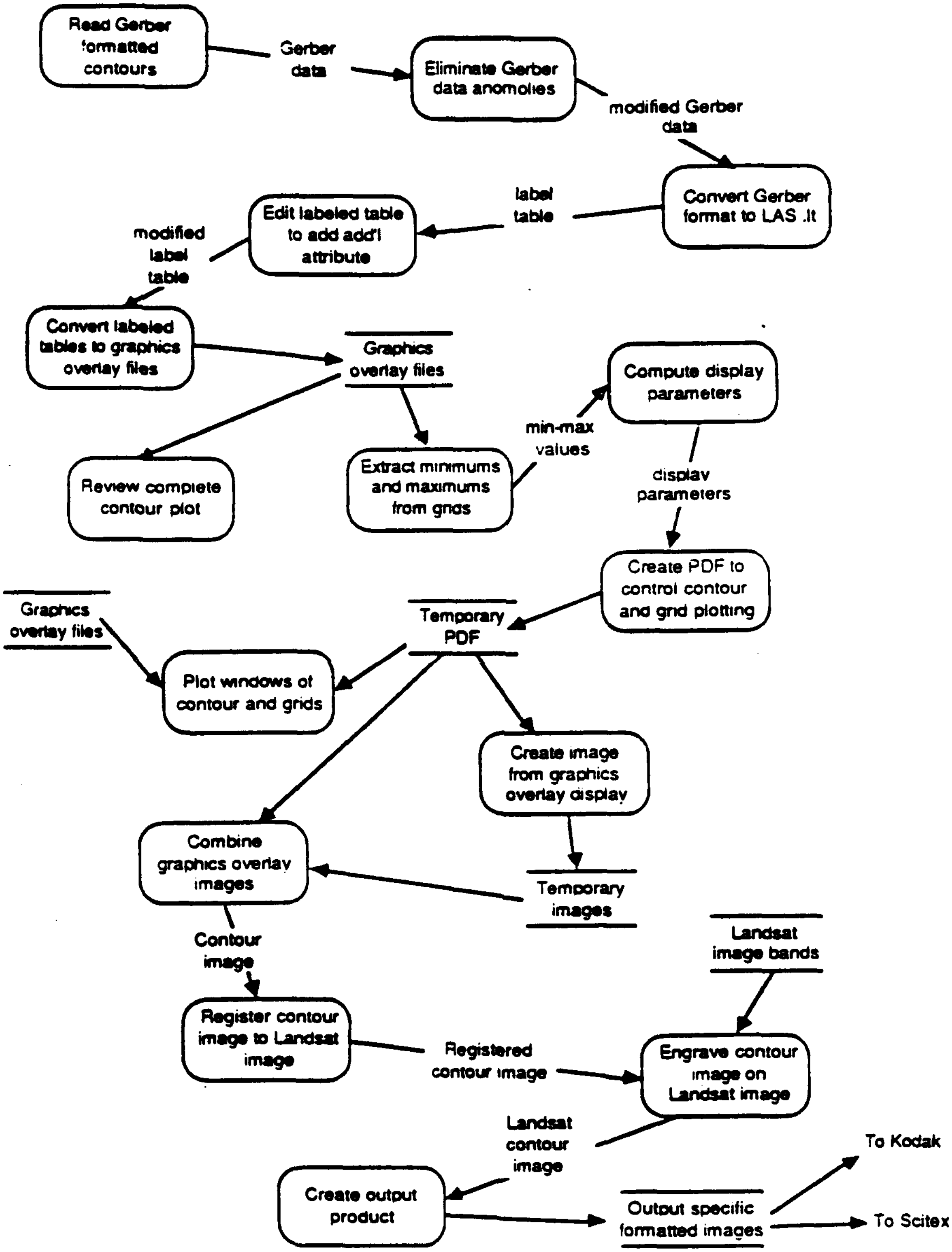

Figure A-1 Generating Landsat contour images using existing LAS tools.

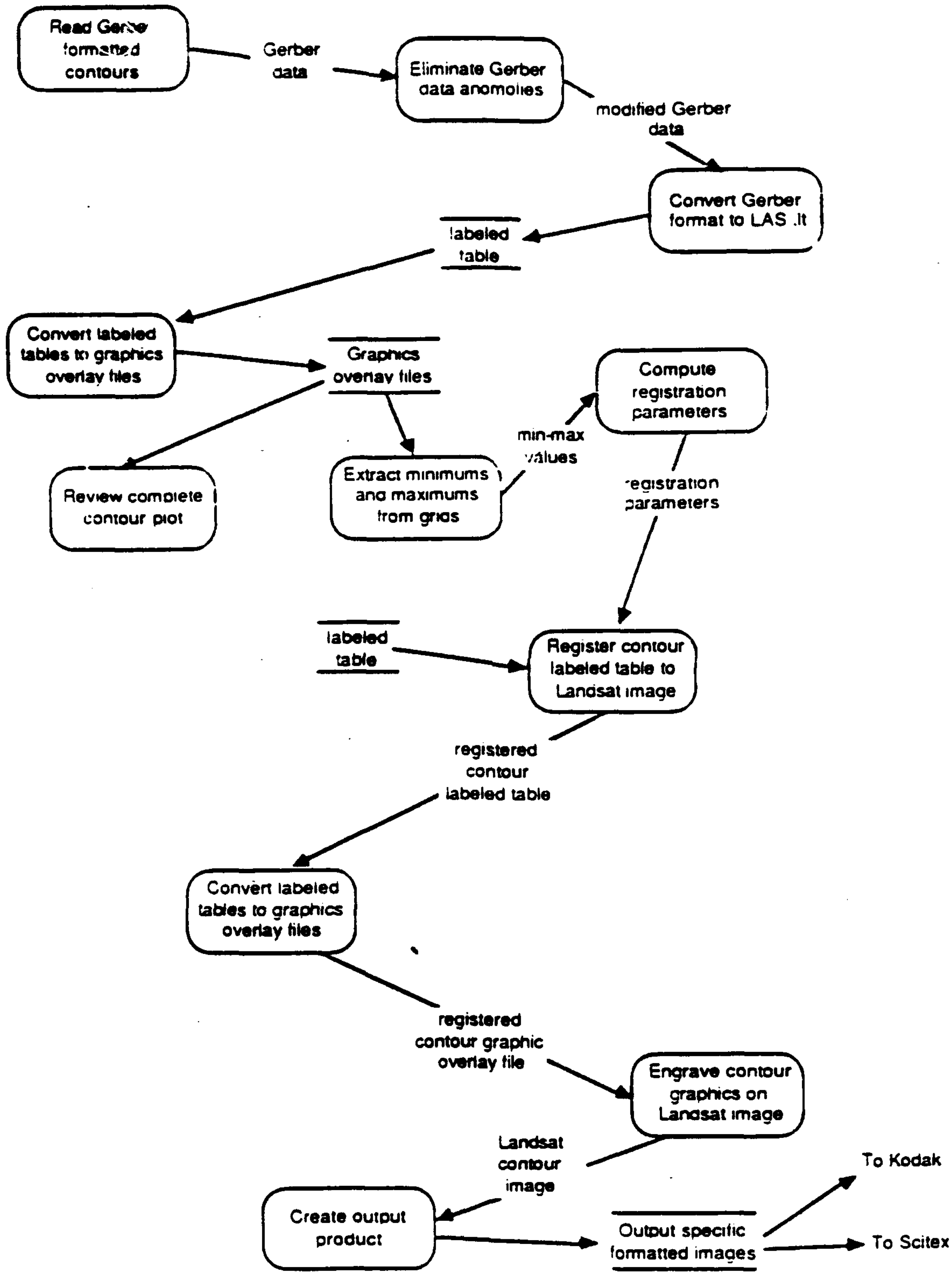

Figure A-2 Recommended production process for generating Landsat contour images using new LAS and specialized software tools.

- Maximum elevation values can be extracted from the DTED. The procedure would consist of registering the DTED (which can be read into the LAS environment by standard LAS 5.0 functions) to the Landsat scene. LAS tools permit extracting the maximum values within a graphics overlay polygon. If polygons are defined to be the desired grid cells, then the maximum elevation can be determined "interactively" for each of the grid cells. That information could then be placed in a graphics overlay point file with each label defined as the maximum elevation. The placement of the label is somewhat related to the position defined by the point feature. Unfortunately, LAS would illustrate the point feature as a point, thus incorrectly implying that the elevation value is related to that specific position and not the entire grid cell.

The following discussion often includes file names in the commands. These are intended to illustrate where some of the existing input and resulting output files are currently located. Care should be taken to avoid destroying a file that was created from time consuming processing.

A.1 Read Gerber Plot Formatted Tape from DMAAC.

DMA-AC provided two sets of contour data covering the Tingo Maria area, with each set consisting of three files. The first file has contour spatial information, the second has contour label information, and the third has the grid line and spot elevation information. The Gerber files were read using the "gerberread" function on an ARC/INFO system (in the Unix environment). The files were then "tarred" to tape, extracted from the tar tape in another Unix environment at PGSC's Reston facility, manipulated and written back to tape in a VMS compatible format, and then extracted from tape in the IEF VAX/VMS environment.

A.2 Edit the Gerber files

All three files have header type of information consisting of plot instructions about product name, product type, projection, scale, contour interval, etc. These headers also contain "sign-off" lines for the various levels of management and cartographic supervisors. These are found in the header as the lines immediately following the text "CHART #". The sign-off lines consist of the commands pen up and move to a location, pen down and move to another location, pen up and move to a third location to place the label of who should initialize the plot. Unfortunately, these commands will become confused with that of a contour. It is more economical to fix the data using an editor than to write specialized software to handle this case. The fix is to either delete that portion of the text, or put a G01 in front of the D01 and the 2nd D02 codes. In this manner, the next processing step will ignore the spatial coordinates for the output files.

At the very end of the contour file, the last contour begins with the pen up and pen down sequence for the first two coordinates. It also has a pen up (D02) for the very last coordinate which is a value totally unrelated to the contour. Use the editor to put a G01 code in front of the X preceding this D02.

The final problem area pertains to the grid lines. The grid lines are plotted on the Gerber plotter, in the case of the files received, as a single set of pen up and pen down commands. The "initializer" code of G01 is used only at the first coordinate. Although they would appear correctly on the Gerber plotter, the LAS conversion software would treat the information as a single entity, and the lines which join the segments of the grid lines would also be visible. The action that is needed is to insert the G01 code in front of each grid line segment. This could be accomplished by searching for "D01" and inserting ""G01" after the "D01". (Do that operation 8 times.)

A.3 Create Labeled Table Files for Future GOF

Use the program **ger2tbl**[2] and the command file **user:[mikeg.g2t]rung.com**. The command file handles some of the dialogue for file names that are then passed to the program ger2tbl. The command file then executes the program with the names as command line arguments; thus, a symbol for the executable is needed:

g :== user:[mikeg.g2t]ger2tbl .

The program is currently hardwired to divide each coordinate by two[3] because LAS cannot handle coordinate values in excess of 20000, and the data set at hand exceeds that value.

There are three files output to the **rung.com** command file procedure:

1. The labeled table attribute file, using the 2nd argument provided to **rung.com**. The file name should be of the form **<name>.lt.**
2. The labeled table coordinate file, using the 2nd argument provided to rung.com with the character 1 appended to it.
3. A summary of the number of coordinates contained for each contour, and the "cont_ind" attribute value of CONTINUOUS or BROKEN. This output will go to the file specified by the

[2]**ger2tbl** is made up of the following modules: **ger2tbl.c** (main), **ger2tbl_att.c**, **ger2tbl_xy.c**, and **ger2tbl_prsxy.c**.

[3]Yes, hardwired, but in module **ger2tbl_halfxy.c** with entry point of **ger2tbl_prsxy()**. Not the best software engineering method, but it was needed to get past the initial LAS obstacle of discovering how to work with graphics overlay files in LAS.

3^{rd} argument: if it is blank, and remains so after the command file queries for it, then the output goes to the terminal.

An explanation of the CONTINUOUS or BROKEN attribute: If a contour (i.e., spatial coordinate stream) has one pen-up and one pen-down code, then it is declared as CONTINUOUS. If it has more than one of either pen-up or pen-down codes, then it is declared as "BROKEN". (More about this later, in SHOGOF.)

A.4 Create Two Labeled Tables: Grid and Contour

Use the first of the 3 Gerber files to create the labeled tables for the contour spatial information to be loaded into a Graphics Overlay File. Use the third of the 3 Gerber files to create the labeled tables for the geographic grid to be loaded into another Graphics Overlay File. Both are needed, even though the grid is not of interest for the final image / contour scene. The grid is essential for determining the range of coordinate values which will eventually be used to spatially register contours to the image scene. Illustration of the commands for some specific file names:

```
@user:[mikeg.g2t]rung grd500.gbr halfgrid.lt grid.sum
@user:[mikeg.g2t]rung con500.gbr halftingo.lt halftingo.sum
```

where grd500.gbr and con500.gbr represent the names of the Gerber formatted data files (for the 500 meter interval data), halfgrid.lt and halftingo.lt are the output file name stems, and grid.sum and halftingo.sum are the summary file names for grid and contour cases respectively. To use files already "cleaned up" by the editor, use [mikeg.gridexp]grid500.mjg and [mikeg.500cont]c500.gbr instead of the files grd500.gbr and con500.gbr, respectively.

A.5 Create GOF for Grid and Contour Gerber Data

Now is the time to convert the data to the LAS environment. After entering LAS, the PDF to be used is called **tab2gof**, which converts a labeled table pair of files to the LAS structured **<name>.GOF_LINE** file. The following illustrates the commands:

```
tab2gof init=halfgrid outgof=halfgrid
tab2gof init=halftingo outgof=halftingo
```

where the first argument, halfgrid500 and halftingo500, contains the labeled table name stems (as used by the @user:[mikeg.g2t]rung command above), and the second argument is used to form the files halfgrid.GOF_LINE and halftingo.GOF_LINE.

A.6 Allocate the display

The display <u>must</u> be allocated before the next step is performed. The command is simply either

```
alloc <display_name>
```

or

alloc <display_name> no

where <display_name> is either lores1 or lores2. It is important to note that if the first command is used, any ARL files in the directory will be deleted, whereas the second one will not cause the deletion. If the last session on LAS was at a different workstation, saving the ARLs will not be useful because they will have the wrong name.

A.7 Load Active Records List (ARL) File for Grid and Contour GOF files

Before the graphics could be plotted, the ARL must be created. The command with possible file names:

lodgof ftype=line infile=halfgrid arlfile=grid

lodgof ftype=line infile=halfcontour arlfile=contour

In these cases, the input files are halfgird.gof_line and halfcontour.gof_line, the output active records list files are <terminal_id>grid.line and <terminal_id>contour.line.

A.8 List Coordinates of Grid GOF File

The command is:

lstgof-arl ftype=line arlfile=grid print=lp outform=long listflg=yes

The goals are two fold: first, to note the coordinate system, and second, to use the coordinates to determine the proper display parameters for later production processing.

Coordinate system: If a coordinate pair (a,b) found in the Gerber file, and also in the labeled table file, is examined in the listing, it will be noted that it appears as (b,a). In the case of the Gerber input, the coordinate system is "xy", whereas in LAS, the coordinate system is "yx" or "scan line, scan sample". The part that is not obvious is that the (1,1) coordinate in the Gerber file is at the lower left, while (1,1) is at the upper left within LAS. Thus, eventually, the coordinates need to be flipped top to bottom.

Display parameters: Determine the minimum and maximum values used for the end points of the grid lines. That will be needed to select the "best" display parameters when viewing sub-windows of the grid and contour data at the largest possible scale. In the case of the DMAAC contours which were scaled by a factor of 0.5, the interesting values are:

	(line,	sample)
Upper Left:	(3195,	841)
Lower Right:	(14079,	11659)

(NL, NS) (10885, 10819)

A.9 Display Graphics for Grid GOF_LINE file (sanity check)

The initial command is:

shogof-noimg ftype=line arifile=grid

After the program performs some preliminary processing, the user is prompted for some additional information. The appropriate responses to the "LAS-SHODYN>" prompts for the first time are:

LAS-SHODYN> ***s*** **! select**

LAS-SHODYN> ***ftype=line*** **! select only line**

LAS-SHODYN> ***atrval=("cont_ind:")*** **! select all**

LAS-SHODYN> ***sa*** **! save for next time**

LAS-SHODYN> ***ru*** **! run, i.e., display those that satisfy the selection criteria**

LAS-SHODYN> ***e*** **! exit shogof**

A.10 Display Graphics for Contour GOF file (sanity check)

The initial command is:

shogof-noimg ftype=line arifile=contour[4]

---

[4]If there is a problem with shogof "bombing", some remedial action is required. It is surmised that memory is exceeded because of the large volume of spatial coordinates. In the past, the program bombs before displaying the entire set of contours; re-executing shogof will continue to bomb at the same file location unless additional attributes are defined. For example, let the first hundred contours have the attribute name and value of DSP:1, the second hundred have DSP:2, etc. (That could be performed in the labeled table attribute file for the contours; half4tingo.lt and half4tingo.gof_line are examples of such an implementation of that strategy). In this manner, cycle through the attribute subsets until (or before) the program bombs, re-execute shogof-noimg and select the appropriate contour subsets.

LAS> shogof-noimg ftype=line arifile=contour

LAS-SHODYN> s

LAS-SHODYN> ftype=line

LAS-SHODYN> atrval=("dsp:1")

LAS-SHODYN> ru

LAS-SHODYN> atrval=("dsp:2")

LAS-SHODYN> ru

LAS-SHODYN> atrval=("dsp:3")

LAS-SHODYN> ru

...

As in the case of the grid GOF, additional interaction is required. A simple response may be used if the "save" was used above:

```
LAS-SHODYN> s          ! select
LAS-SHODYN> re         ! restore the ftype and atrval saved above
LAS-SHODYN> ru         ! run
LAS-SHODYN> e          ! exit shogof
```

A.11 Display Graphics for Contour GOF file (Improved sanity check)

The following two commands are similar to the above. In the above commands, GOF coordinate (1,1) corresponds to the upper left corner of the display; the following commands force the minimum scan line and sample coordinates to correspond to the upper left corner of the display:

```
shogof-noimg ftype=line arifile=grid window=(min_sl, min_ss, +
total_ss, total_sl)
shogof-noimg ftype=line arifile=contour window=(min_sl, min_ss, +
total_ss, total_sl)
```

where

min_sl = minimum of the scan line coordinates

min_ss = minimum of the scan sample coordinates

total_sl = maximum of the scan line coordinates - min_sl + 1

total_ss = maximum of the scan sample coordinates - min_ss + 1

A.12 Create Contour Image to Register to Image Scene

There is not an existing LAS mechanism to register a graphics overlay to an image. Thus, the methodology that is necessary is to create an image of the contours, which is then registered to the desired image scene. There is also no procedure within LAS 5.0 to convert from a graphics overlay to an image. The procedure is then to display a portion of the graphics on the display (using SHOGOF-NOIMG), and then create a 512^2 image of the graphic display using (FRMDSP). By being judicious in the specification of windows of the graphics overlay file, multiple images can be generated and then combined appropriately to yield an image scene with a scale close to that of the Landsat scene.

```
LAS-SHODYN> e
```

The first step in the process is to compute the window size to be used by SHOGOF. As the Tingo Maria scene has dimensions of 2220 by 2206, the appropriate size for the the recombined contour image is 2048 by 2048. (A smaller size will yield excessive pixel replication during the registration process, which will increase the contour line weight; a larger size will yield excessive pixel drop out, thus degrading the contours with discontinuities.) The 2048^2 contour scene can be obtained by creating a 4 by 4 array of 512^2 contour images.

SHOGOF scales graphics by integer values, thus it is important to determine the optimal contour information that can be displayed. This can be computed first using the formula to determine the scale that SHOGOF will use:

scale = max { integer [(total_sl + 2047) / 2048], integer [(total_ss + 2047) / 2048] }

The number of scan lines and scan samples that will fit on the 512^2 display is then scale * 512. In the case of the contours for the Tingo Maria area, the scale factor is 6, thus windows into the contour GOF file should be dimensioned 3072^2.

The procedure is then to display the graphics overlay file 16 times using SHOGOF with the appropriate spatial window; note that each execution of SHOGOF must be preceded by a clean display, and followed by creating an image file with a meaningful name. Although this is a simple concept, it has the potential for operator error. To ensure that the process be performed in as operator error free mode as possible, a DCL command file (called LOOP) was created to eliminate numerical, typographic and file naming errors. It simply creates a PDF which will perform the 16 operations, followed by combining the 16 images into a single 2048^2 contour image.

The following commands should be performed (in the VMS environment, not LAS) for both the grid and contour graphics overlay files. As mentioned before, the usefulness of the grid file is simply for registration purposes. The industrious user might prefer to compute the coordinates instead of selecting them from the display, thus saving 30-40 minutes of processing time. (This "loop" command file is "hardwired" to the Tingo Maria contour file. It uses the min_sl and min_ss values from that specific grid file, it assumes 4^2 images to form an output of 2048^2. It should be generalized if other contour files are used or different output dimensions are desired.)

```
@user:[mikeg.gridexp]loop 3072 grid grid3072
@user:[mikeg.gridexp]loop 3072 contour contour3072
```

The first argument is the window into GOF, the second argument defines that ARL file, and the third defines the output PDF file (which will have ".pdf" appended to it). A copy of the grid3072.pdf and contour3072.pdf files are attached. Then, in the LAS environment, simply type the name of the PDF:

grid3072

contour3072[5]

Unfortunately, interactive responses are still required. Those responses are to the "LAS-SHODYN>" prompts. For the first display window, the responses are:

LAS-SHODYN> *s*	**! select**	
LAS-SHODYN> *ftype=line*	**! select only line**	
LAS-SHODYN> *atrval=("cont_ind:continuous")*		**! select only those with the continuous attribute** [6]
LAS-SHODYN> *sa*	**! save for next time**	
LAS-SHODYN> *ru*	**! run, i.e., display those that satisfy selection criteria**	
LAS-SHODYN> *e*	**! exit shogof**	

Subsequent windows need the simpler responses:

LAS-SHODYN> s	**! select**
LAS-SHODYN> re	**! restore the ftype and atrval saved above**
LAS-SHODYN> ru	**! run**
LAS-SHODYN> e	**! exit shogof**

After all 16 images are created, the PDF will proceed to combine them into the 2048^2 scene, with the image file name defined by <2nd argument><1st argument>. The intermediate image files, history files, and DDR files (with names <2nd argument><1st argument>_nm) should be deleted after it is verified that the larger scene was generated correctly.

---

[5]Approximately 3 hours are needed to execute this PDF. (Approximately 10 minutes for each of the 16 scenes with some additional time to combine them all together.)

[6]It was noted that those contours with attribute values of "cont_ind:broken" are redundant versions of some contours with "cont_ind:continuous", with some spatial alignment discrepencies. It seemed adequate to simply display those contours that were "continuous".

A.13 Register the Contour Image to the Landsat Image

The next step is to register the contour to the image scene. The 4 corner points of the grid are measured by various LAS functions. It could be performed via an interactive session with the image and the contours both displayed, but that is unnecessary. The approach that is simpler is to select a portion of the image and then to zoom in and select a grid corner point. The following illustrates this:

```
todsp  in="grid3072(1,1,512,512)"
zoomcur
todsp  in="grid3072(1,1537,512,512)"
zoomcur
todsp  in="grid3072(1537,1,512,512)"
zoomcur
todsp  in="grid3072(1,1,512,512)"
zoomcur
```

(After each zoomcur command, select UL, UR, LL, and LR coordinates of the grid, respectively; e.g., (1,2), (1,1802), (1814,1), and (1814,1804) for the Tingo Maria contours.)

Next perform the registration of the contour image (contour3072) to the image scene by using EDITTIE, POLYFIT, and GEOM LAS functions[7]. When using EDITTIE, remember that the upper left (UL) grid coordinate is to match the lower left (LL) image coordinate, UR grid -> LR image, LR grid -> UR image, and LL grid -> UL image.

A.14 Review the Results of the Registration

Review the results by various LAS display tools: TODSP, SCAN, or WINDOW. Some examples:

```
window in="reg_contours3072 + tingo7"
todsp in="reg_contours3072(256,256,512,512)  +  tingo4(256,256,512,512)"
scan reg_contours3072
```

A.15 Combine the Image Contour with Landsat Image Scene

This step "engraves" the contour image onto the Landsat scene so that the contours appear yellow on the image.

---

[7]Some relevant parameters: no correlation, 1^{st} order transformation, image is the reference scene, grid is the sample scene, inverse transformation, nearest neighbor resampling. The Tingo scene has 2220 scan lines and 2206 samples.

```
concat-manual in=(tingo7 reg_contours) out=t7_cont3072 +
SL=(1 1) SS=(1 1) NL=2220 NS=2206 +
maskval=(0 0) overopt=(replac replac)

concat-manual in=(tingo4 reg_contours) out=t4_cont3072 +
SL=(1 1) SS=(1 1) NL=2220 NS=2206 +
maskval=(0 0) overopt=(replac replac)

map  in=reg_contours3072 out=neg_reg_contours +
from=(0 255) to=(255 0)

concat-manual in=(tingo2 neg_reg_contours) out=t2_cont3072 +
SL=(1 1) SS=(1 1) NL=2220 NS=2206 +
maskval=(0 255) overopt=(replac replac)
```

A.16 Review the Final Images and Output Them to Hardcopy Device

The resulting three (single band) images, t7_cont, t4_cont, and t2_cont, correspond to the red, green, and blue bands, respectively. They should be reviewed together or individually with TODSP, WINDOW, and SCAN for final quality control. Some examples:

```
window in="t7_cont + t4_cont + t2_cont"
todsp in="t7_cont(256,256,512,512)  +  t4_cont(256,256,512,512)"
scan t2_cont
```

These may then be used for display purposes, or for output to the Kodak printer or Scitex Plotter.

MISSION

OF

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